



Development of Jamun (*Syzygium cumini* L.) fruit blended set and stirred yoghurts

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General Note

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ABSTRACT

Fermented milk products play an important role in humans' daily diet. The subtropical climate of India made it essential to devise India's own modes of milk preservation. Yoghurt is one of the most unique dairy product, yet a universal one. Studies have provided evidence for beneficial role of yoghurt in the human digestion and physiology. Yoghurt has now become a popular subject for researchers worldwide as it is claimed as a health food. In this study, an attempt was made to develop jamun fruit blended set and stirred yoghurts. The products were developed by blending jamun fruit pulp at different levels of milk. The samples were served to a panel of judges to evaluate the quality using 9 point hedonic scale. Among the different fruit pulp levels, 9 % pulp level was found to be the best for both set and stirred yoghurts. A uniqueness of the product was that it was not added with any artificial or synthetic colour and flavour. From the sensory quality and microbiological analysis, it was deduced that the yoghurt products had a shelf-life well over 21 days in refrigeration storage and totally free from the presence of coliforms and least counts of yeast and molds which were much below the PFA Standard Limits for yoghurt. The fruit additives not only improved the sensory qualities of the developed value added set and stirred yoghurts, but also enhanced the nutritional contents of the products.

1. INTRODUCTION

The most popular milk based products in the world are fermented milk due to high nutritional and therapeutic values. In addition, these products have other added benefits, such as unique flavour, body and textural properties. Some of the popular fermented milk products are shrikhand, dahi, *lassi*, yoghurt, kumiss, kefir, acidophilus milk and Bulgarian butter milk (Kosikowski, 1997). Fermented milk products play an important role in man's daily diet. Various fermented milk products which suited the needs and tastes of its inhabitants were developed. Over the years, fermented milk became an indispensable supplement to the stable food consumed every day. Studies have provided evidence for beneficial role of yoghurt in the human digestion and physiology. Yoghurt cultures produce certain metabolites during their growth in the product that allow the milk protein to be digested and have definite antagonistic effect against food borne pathogens. Yoghurt has now become a popular subject for researchers worldwide as it is claimed as a health food. Zemel (2005) has reported that consumption of low-fat yoghurt can promote weight loss, especially due to calcium in yoghurt. Yoghurt containing live cultures has been found effective in preventing antibiotic-associated diarrhea. Keeping in view the benefits of yoghurt, a study was undertaken to develop and formulate jamun fruit blended set and stirred yoghurts at the University of Agricultural Sciences, Bengaluru, India.

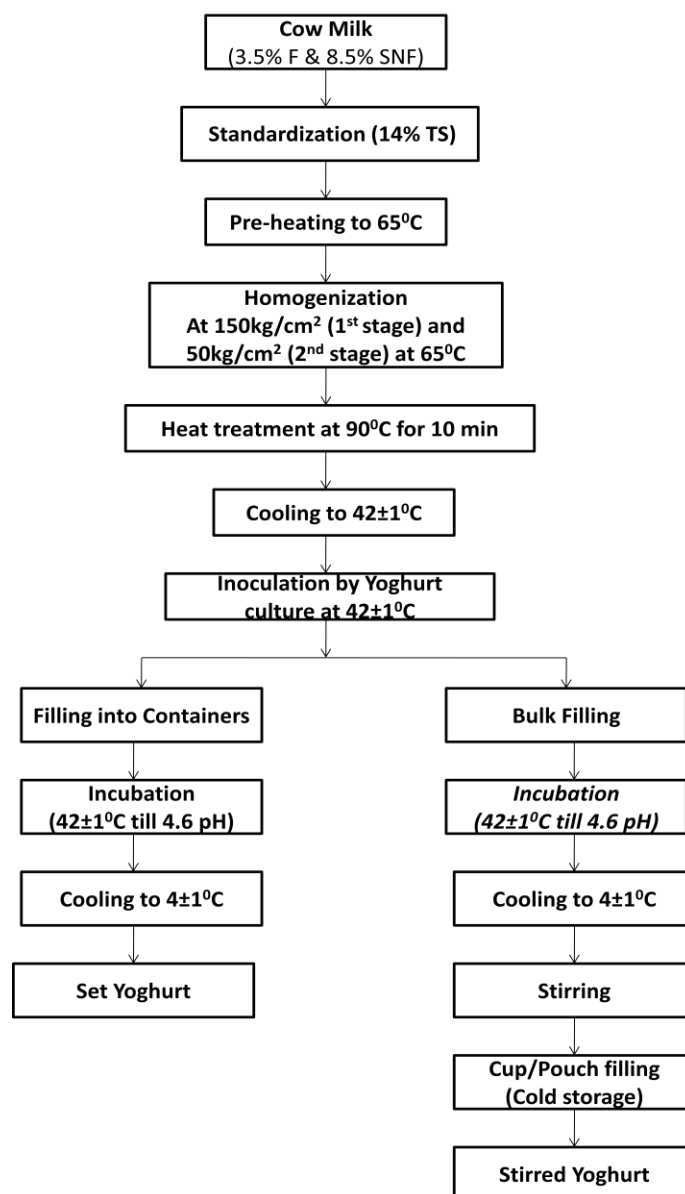


Figure 1 Flow diagram for development of plain yoghurt (control)

2. MATERIAL AND METHODS

Development of yoghurt

Nandini Brand of Karnataka Milk Federation (KMF) cow milk (3.5 % fat, 3.3 % protein and 12 % TS) was procured from the Mother Dairy, Bengaluru and used for yoghurt production as per the process procedure by Tamime and Robinson (2007). The mix was pasteurized at 90°C for 10 min. and then cooled immediately to 42±1 °C. Freeze dried cultures, *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* were added into the mix at the rate of 20 DCU/100 litre to serve as the starter culture. The inoculated mix was filled into 100 ml plastic cups and incubated at 42±1 °C till the mix attained a pH of 4.6. The product was then transferred to a refrigerator at 4±1 °C and stored (Figure 1). This served as the control yoghurt sample. For development of value added fruit blended yoghurt (set) 6 to 10 % (w/v) of jamun pulp was added to the yoghurt mix after heat treatment and cooled to 42±1 °C prior to inoculation (Figure 2).

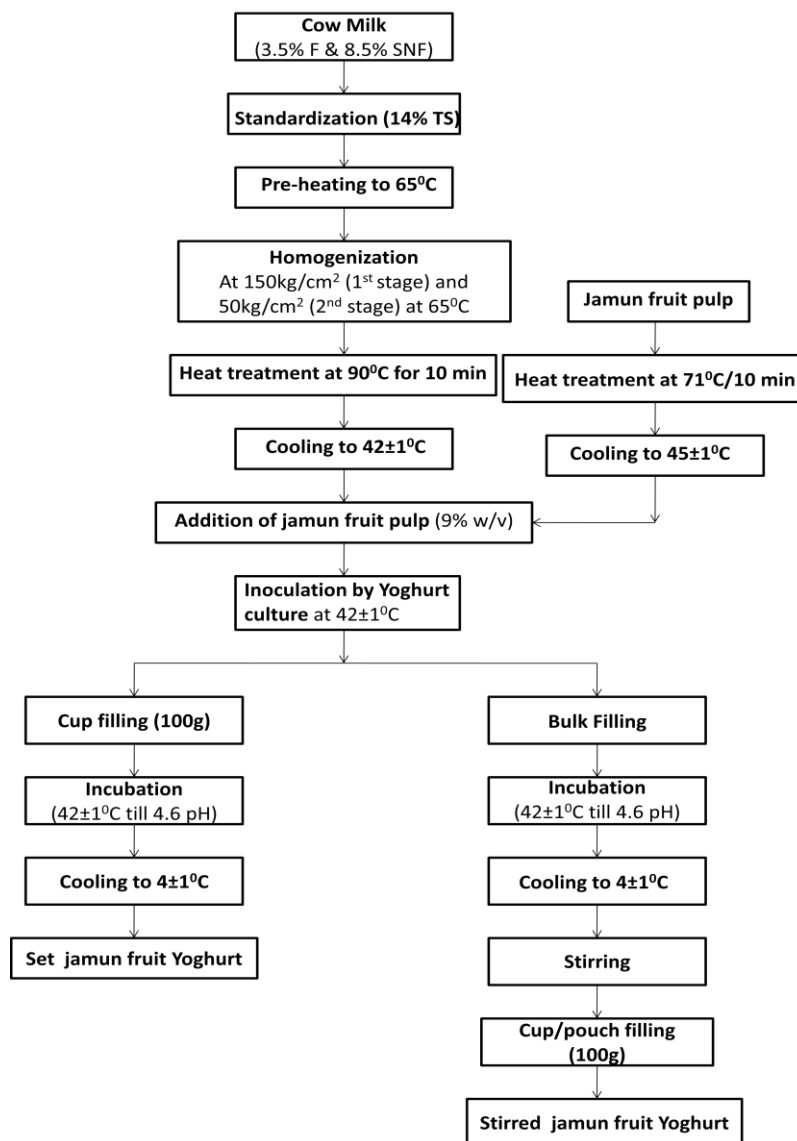


Figure 2 Flow diagram for development of jamun fruit stirred yoghurt

Optimization of blending of fruit pulp to develop fruit yoghurt

During the production of fruit flavoured yoghurt, Nandini Brand (KMF) cow milk (3.5 % fat, 3.3 % protein and 12 % TS) was standardized to 14 % TS by adding skim milk powder. The yoghurt mix was pasteurized at 90 °C for 10 min. and cooled to 42±1 °C. Further, the fruit pulp was heated to 71 °C for 5 min. and cooled to 45±1 °C and was added to milk. Then freeze dried cultures, *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* were added at the rate of 20 DCU/100 litre. The bulk

yoghurt mix sample was then filled in 100 g plastic cups for Set yoghurt. This mix was incubated in bulk at 42 ± 1 °C till it attained a pH of 4.6. The bulk yoghurt samples were stirred and filled in 100 g plastic cups. The value added yoghurt samples and control sample were stored in a refrigerator at 4 ± 1 °C. At the end of storage period, the product was subjected to microbiological analyses and sensory evaluation. The pH of the samples was measured using a digital pH meter (MICROPRO, Labmate). The microbiological analysis of the developed value added products was carried out as per the Standard methods for coliforms, yeast and molds using the violet red bile agar (VRBA) and potato dextrose agar (PDA), respectively. Three dilution factors (10^0 , 10^{-1} and 10^{-2}) were used for plating of coliforms, yeasts and molds. The number of microbial counts was calculated using the following equation:

$$\text{No. of microorganisms/g} = \frac{\text{No. of colonies} \times \text{dilution factor}}{\text{Weight of aliquate taken (g)}}$$

The sensory analysis was carried out by serving developed yoghurt samples and control samples to a panel of judges and analyzed using 9 point hedonic scale for colour and appearance, consistency, flavour and overall acceptance. The samples were code numbered to avoid any bias in evaluation. The shelf-life of the developed yoghurt samples (both Set and Stirred) were studied for 21 days storage at 4 ± 1 °C. The results were subjected to the Analysis of Variance (ANOVA) using Factorial CRD procedure. The means were separated by using the least significant difference (LSD) at $\alpha = 0.05$ level.

3. RESULTS AND DISCUSSION

Process optimization of jamun fruit Set and Stirred yoghurts

The results obtained in the process of optimization for developing value added jamun set and stirred yoghurts are presented Tables 1 and 2. The sensory scores recorded for colour and appearance, consistency, flavour and overall acceptability for set fruit yoghurt samples at different pulp levels (6, 7, 8, 9 and 10 %) are presented in Table 1.

Table 1 Sensory evaluation of set yoghurt at different jamun pulp levels

Parameter	Pulp level (%)				
	6	7	8	9	10
Colour & appearance	7.75	7.89	8.03	8.33	7.88
Body & texture	7.60	7.50	7.80	8.16	7.99
Flavour	7.87	8.00	8.02	8.15	8.02
Overall acceptability	7.92	8.17	8.29	8.56	7.93
Cal F-value	0.7345	3.4283*	2.1700	1.5606	0.1201
S.E _m ±	0.1692	0.1544	0.1359	0.1555	0.1801
C.D	0.6509	0.5940	0.5229	0.5980	0.6928

The sensory scores with respect to colour and appearance of set yoghurt samples increased significantly when the jamun pulp content was increased from 6 to 9%. However, further increase in the pulp level (10 %) was resulted in the decrease of sensory score (7.93). The yoghurt sample with 9 % pulp secured the highest sensory score (8.33) while sample at 6 % pulp secured the lowest (7.75). The statistical analysis revealed that the variation in pulp levels had no significant effect on the colour and appearance. The sensory scores for body and texture showed an increasing trend with increase in pulp level from 6 to 9 %. The pulp level of 9 % (8.16) secured the highest sensory value. In case of flavour, there was a significant increase in sensory scores of samples from 6 to 9 %, and beyond 9 %, the sensory scores declined. The samples at 9 % jamun pulp (8.56) had the highest overall acceptability score followed by 8 % (8.29), 7 % (8.17), 10 % (7.93) and 6 % (7.92), respectively. The fruit pulp level at 9 % had significant effect on colour and appearance, body and texture, and overall acceptability of Set yoghurt. Further, increase of pulp level had influenced decreased sensory scores. Earlier studies suggested that mango and pineapple pulps used at 7 % level secured highest sensory scores of 8.23 and 8.14, while banana pulp at 9 % level secured a score of 8.25 in respect of overall acceptability (Amna *et al.*, 2008). This development of jamun yoghurt might add to the diversity of presentation of the product.

Jamun fruit pulp levels on the sensory quality of Stirred yoghurt

In case stirred yoghurt samples at pulp levels of 6, 7, 8, 9 and 10 % showed significant differences in the sensory scores for colour and appearance (Table 2). The sample of 9 % jamun pulp scored significantly high value (8.25) followed by 7 % pulp sample (7.94).

The yoghurt sample containing 6 % pulp had secured least sensory value of 7.49. The sensory scores with respect to body and texture attributes of stirred yoghurt samples at pulp levels at 6, 7, 8, 9 and 10 % were found non-significant. However, the 9 % pulp yoghurt sample secured slightly higher sensory score of 8.07 compared to 8 % (7.77), 10 % (7.68), 7 % (7.65) and 6 % (7.45) pulp levels.

Table 2 Sensory evaluation stirred yoghurt at different jamun pulp levels

Parameter	Pulp level (%)				
	6	7	8	9	10
Colour & appearance	7.49	7.94	7.90	8.25	7.60
Body & texture	7.40	7.65	7.77	8.07	7.68
Flavour	7.45	7.60	8.02	7.82	7.81
Overall acceptability	7.45	7.79	7.96	8.10	7.34
Cal. F-value	0.0527	1.7035	0.6110	1.4825	2.9447*
S.E _m ±	0.1605	0.1171	0.1367	0.1464	0.1154
C.D	0.6174	0.4504	0.5258	0.5632	0.4441

The flavour attribute of the stirred fruit yoghurt samples with 8 % pulp level secured significantly higher score (8.02) compared to other samples. The samples of pulp level at 9 % (7.82), 10 % (7.81), 7 % (7.6) and 6 % (7.45) were found non-significant among them. Significant differences were found in case of overall acceptability of stirred yoghurt at different jamun pulp levels. The sample at 9 % pulp level secured significantly higher sensory value (8.1) for overall acceptability among the five stirred yoghurt samples studied. The sample at 8 % pulp level scored moderately high (7.96) followed by 7 % (7.79), 6 % (7.45) and 10 % (7.34) pulp levels. The fruit pulp at 9 % was considered for stirred yoghurt for further storage studies. The pulp level at 9 % had significant effect on colour and appearance, body and texture, flavour and overall acceptability of set yoghurt as indicated by the high sensory scores. Further, increase in pulp level caused decrease in sensory scores, a repetition that was observed in the case of set yoghurt and opined that 8 % pulp was the most suitable level for development of best quality fruit stirred apple and banana yoghurt (Amna *et al.*, (2008). In the present study, the jamun fruit pulp at 9 % level was found to be the best blend. The samples were evaluated for sensory attributes of colour and appearance, body and texture, flavour and overall acceptability. The yoghurt secured highest sensory score for overall acceptability attributing to its superior pulp flavour, very good texture and appearance.

Sensory quality of Set and Stirred yoghurts during storage at 4±1°C

The results pertaining to the effect of addition of 9 % fruit pulp on the developed value added yoghurts (set & stirred) samples are presented in Figure 3. It can be observed that sensory scores for set yoghurt started decreasing slowly compared to the stirred yoghurt during first five days and thereafter, found slightly increased scores for the rest of storage. The sensory score for colour and appearance decreased gradually during storage. The rate of decrease for the stirred fruit yoghurt was much slower compared to the set fruit yoghurt as reflected by the sensory scores (8.1) on the 21st day for set yoghurt as opposed to the stirred yoghurt (8.0). However, both set and stirred fruit yoghurts were found acceptable with respect to color and appearance on the 21st day of storage. The body and texture of the set and stirred yoghurts started decreasing gradually from the 1st day to 21st day of storage. The final texture of set yoghurt (8.1) was slightly better compared to stirred yoghurt (7.9). The flavour score for set fruit yoghurt was gradually decreasing during storage from the first day to 21st day (from 8.5 to 8.00). While the stirred yoghurt showed an increase (from 8.38 to 8.45) on the third day and thereafter, a gradual decrease on the 21st day (7.8). The set yoghurt sensory scores with respect to flavour were above the stirred yoghurt. The sensory score for the overall acceptability of set and stirred fruit yoghurts decreased as storage continued up to 21st day. The overall acceptability score on the 21st day showed that the set (8.1) and stirred (7.78) yoghurts were moderately preferred. The set yoghurt scores remained above the stirred yoghurt except for the first three days. From the results of the sensory analysis it could be observed that the products were still in good condition and acceptable up to 21 days of storage at 4±1°C temperature. The overall acceptability scores before storage was 8.65 for set yoghurt and 8.58 for stirred yoghurt and scores were 7.80 and 7.78 at the end of 21 days storage, respectively.

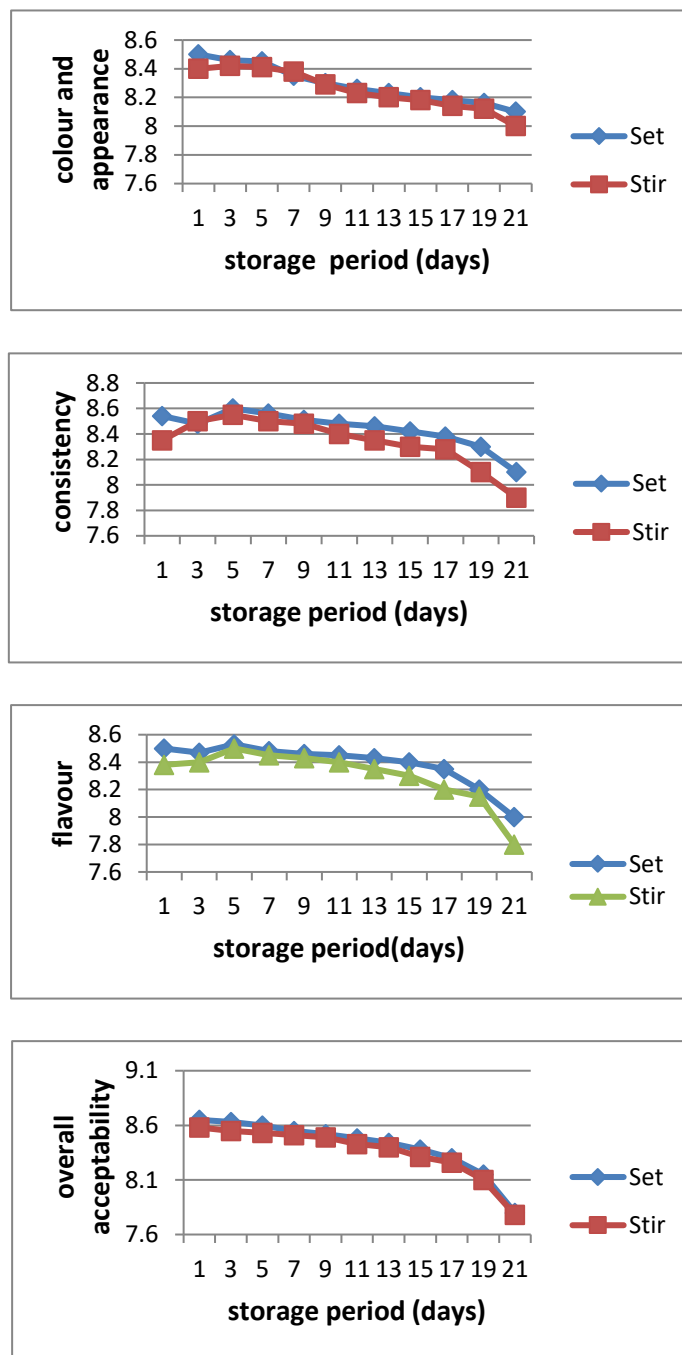


Figure 3 Sensory quality of value added yoghurts (set & stirred) during storage at 4 ± 1 °C

Bio-chemical composition of jamun yoghurt

The compositional details of yoghurts are presented in Table 3. The jamun fruit blended yoghurt was having an average composition of 17.44 % total solids, 4.59 % protein, 3.32 % fat, 9.12 % carbohydrate and 1.08 % ash. The protein content of the developed yoghurts were higher (4.59%) compared to normal yoghurt (3.25%).

Table 3 Chemical composition of developed jamun yoghurt samples

Parameter	Jamun yoghurt sample (9 % w/v)
Total solids	17.44
Protein	4.59

Fat	3.32
Carbohydrates	9.12
Ash content	1.08

pH

As the storage period extended, the pH values of both set and stirred fruit yoghurts also decreased (Fig 4). The drop in pH was little faster from zero day to 5th day and then decreased gradually during the remaining storage up to 21 days.

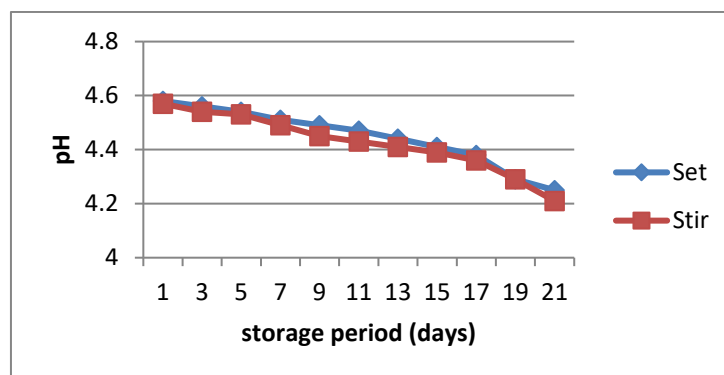


Figure 4 pH of value added set and stirred yoghurts during storage at $4 \pm 1^\circ\text{C}$

The pH of set yoghurt remained slightly higher than the stirred yoghurt during storage. The pH of yoghurts decreased from 4.58 for set yoghurt and 4.57 for stirred yoghurt from 4.25 and 4.2, respectively, during storage. The pH values of set yoghurt remained slightly above the stirred yoghurt. According to Nafiseh *et al.* (2008), microorganism's activity in yoghurt caused pH to decrease. Also, yeasts used sugar and organic acids and hence, the pH value was decreased.

Microbiological quality

The microbial counts (yeasts, molds and coliforms) of the value added set and stirred yoghurt samples stored in refrigeration temperature were analyzed at an interval of 2 days during storage. The results are presented in Table 4. From Table 4, it could be observed that no coliform counts were found in both set and stirred jamun fruit yoghurts during the entire storage of 21 days. No yeast and mold counts were observed till 5th day of storage in both set and stirred yoghurts. A gradual increase up to 10 cfu/g was observed in both set and stir yoghurts at the end of 21 days of storage. The result satisfies the PFA Standards for yoghurt which specifies zero counts of coliforms per gram. This might be attributed to the high acidity of yoghurt wherein potential pathogens like coliforms cannot survive and also since refrigeration condition used for yoghurt storage and pH reduction could have made unfavorable conditions for the coliforms to grow (Nafiseh *et al.* 2008). The competition with lactic acid bacteria caused difficult situation for coliforms activity and hence, these microorganisms were inactive (Frazier and Westhoff, 1995). For this reason Yadav *et al.*, (1993) stated that yoghurt could be considered as a hygienically safe food product. No yeast and mold counts were observed till the 5th day of storage both in set and stirred yoghurts. A gradual increase to 10 cfu/g was observed in both set and stir yoghurts on 21st day of storage. Yeast and mold were absent before storage in the set yoghurt, but appeared on the 5th day (1 cfu/g), and the counts increased with storage period up to 8 cfu/g. This satisfies the PFA specifications for yoghurt that allows a maximum limit of 100 cfu/g of yeasts and molds. Considering the fact that yeast and molds are able to survive in acidic conditions at refrigeration temperatures, the results on appearance and increase in yeast and mold counts are in agreement with findings of Yadav *et al.* (1993) and Frazier and Westhoff (1995). Also, since the cups used in the packaging and storage of both yoghurts did not offer complete sealing from interaction and might have contributed to the presence of yeast and molds in the products. From the microbial analysis, it could be inferred that fruit additives have no influence on the microbial counts of yoghurt (Nafiseh *et al.* 2008). Also, yogurt could have a keeping quality well over 15 days, if processed and packaged properly. This supports the results reported by Tamime and Robinson (2007). The microbial analysis for jamun fruit yoghurt for yeast and mold counts showed completely free from the presence of coliforms throughout the 21 days of storage, and yeast and mold counts (10 cfu/g) up to 21st day. However, this count was much below the regulatory standards limit as defined by the PFA. Thus, from the sensory quality and microbial analysis, it was deduced that all the developed products had the safe shelf-life well over 15 days for yoghurts in refrigeration storage.

Table 4 Microbial counts of Set and Stirred jamun fruit yoghurts during storage

Microbe	Yoghurt	Storage period (days)										
		1	3	5	7	9	11	13	15	17	19	21
Coli forms (cfu/g)	Set	0	0	0	0	0	0	0	0	0	0	0
	Stir	0	0	0	0	0	0	0	0	0	0	0
Yeast & molds (cfu/g)	Set	0	0	0	3	3	5	6	8	8	9	10
	Stir	0	0	0	4	4	5	7	9	9	10	10

The value added set and stirred yoghurts were successfully developed using jamun fruit pulp. This demonstrated that fruit additives not only improved the sensory quality of yoghurt but also coupled with enhanced nutritional aspect of the developed value added products. Also, from the sensory quality and microbiological analysis, it was deduced that the developed yoghurts had a shelf-life well over 3 weeks. The developed jamun fruit blended yoghurts indicate a potential value added products for commercialization.

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